Intellectual demand and formal education as cognitive protection factors in Alzheimer's disease

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Abstract – To investigate the possible association between educational level and previous professional occupation, and objective cognitive and functional evaluation in a sample of elderly patients with Alzheimer's disease. *Methods:* Through retrospective analysis of medical files, 174 patients with probable Alzheimer disease were randomly selected, classified and submitted to analysis according to previous professional occupation and years of formal education. *Results:* Subjects with lower education and less intellectually-demanding occupations performed worse than higher educated subjects in all cognitive subtests and on the functional scale. *Conclusions:* Results indicate that not only the total years of education, but also professional occupation has an impact on cognition and functioning in accordance with the hypothesis of cognitive reserve. Our findings confirmed this hypothesis, where subjects with higher education/ higher intellectual demand manifested first symptoms later than low education/ low intellectual demand subjects, with the latter group also exhibiting faster disease progression.
Key words: educational level, neuropsychological assessment, Alzheimer's disease.

Demanda intelectual e escolaridade formal como fatores de proteção cognitiva na doença de Alzheimer
Resumo – Analisar as possíveis correlações entre nível educacional e atividade profissional prévia, com dados objetivos de avaliação cognitiva e funcional em uma amostra de idosos com doença de Alzheimer. *Métodos:* A partir de análise retrospectiva de prontuário médico foram selecionados aleatoriamente 174 pacientes com provável doença de Alzheimer que foram subdivididos e submetidos a análise conforme sua atividade profissional prévia e nível de escolaridade alcançado formalmente, calculado em anos. *Resultados:* Em praticamente todos os subtestes cognitivos, além de escala funcional, os participantes do grupo menos escolarizado e profissionais de áreas consideradas menos complexas em relação a demanda intelectual, saíram-se pior quando comparados com grupo mais escolarizados. *Conclusões:* Não apenas o total acumulado de anos formais concluídos, mas também a atividade profissional previamente exercida parece ter resultado sobre a cognição e funcionalidade à medida que evolui a doença crônico degenerativa, favorecendo assim o conceito de reserva intelectual. Por esta hipótese espera-se retardo no início dos sintomas da doença em pessoas com alta escolaridade/ alta demanda intelectual e, por outro lado, a baixa escolaridade/ baixa demanda intelectual profissional podem estar associadas a início precoce e progressão mais rápida, tanto do ponto de vista cognitivo como funcional.
Palavras-chave: nível educacional, avaliação neuropsicológica, doença de Alzheimer.

The aging of the human population is a worldwide phenomenon occurring at an ever faster pace. In 1950 there were 204 million elderly people. Five decades later, in 1998, this number had increased to 579 million, with a yearly increase of 8 million elderly. Projections estimate that by 2050 there will be 1900 million elderly, equivalent to the current world population of 14-year-olds. One explanation for this pattern is the worldwide increase since 1950 of 19 years in life expectancy at birth.[1] According to forecasts, by 2050 the population group aged 100 years or older will increase 15-fold, from 145,000 to 2.2 million. In Brazil centenarians numbered 13,865 in 1991, and had increased by 77% to 24,576 by 2000. São Paulo state has the highest number of centenarians (4,457), followed by Bahia (2,808), Minas Gerais (2,765) and Rio de Janeiro (2,029) States. According to a national dwellings sample census (2008)

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there are 21 million elderly in Brazil. Average formal education for this group is 4.1 years, distributed as follows: no education or less than one year (32.2%); one to three years (19.5%); 4 to 8 years (31.3%); 9 years or above (17.1%).

While several investigations consider literacy (basic ability to read and write) as synonymous to education, the correlation is weak, and often there is discordance between the definition and its meanings.[2,3] As an example, in an investigation involving an elderly population, mean formal education was 12 years, but literacy level was similar to that of 5th grade students.[4]

"Literacy" and its antonymous "illiteracy" were coined in the thirties in United States and used in Second World War by the American Army to indicate ability to understand written instructions necessary to execute military tasks. These expressions have subsequently been used to indicate the pragmatic use of reading and writing in home and work daily settings, often set against academic education. In some cases, the expression "functional illiteracy" has been used to indicate a status between absolute illiteracy and partial grasping of rudimentary abilities necessary for "survival in industrial societies".[5]

The ample dissemination of the expression "functional illiteracy" was due basically to a Unesco action that adopted it in the definition of literacy in 1978 to set a standard for education statistics and education strategies among member countries. Unesco's definition of literacy proposed in 1958 referred to the ability to understand written texts or to write a short and simple paragraph on a daily life subject.

Twelve years after Unesco indicated another definition, defining literacy as "functional' when sufficient for adequate integration of a subject into his/her environment, integration which included doing activities for which reading, writing or calculation are necessary.

In parallel with these new definitions there was an increase in life expectancy and an increase in the group of elderly people with neurological degenerative disorders with functional and cognitive decline.

The main objective of this investigation was to analyze the possible correlation between educational level and professional activity, and cognitive performance of a sample of Alzheimer disease subjects followed at a dementia outpatient clinic in the city of São Paulo.

Methods

Subjects

A systematic analysis of demographics, clinical data and neuropsychological evaluation of the medical files of 174 elderly people with a diagnosis of probable Alzheimer disease was conducted in accordance with the Research Ethics Committee guidelines. Diagnosis of probable Alzheimer

disease was reached according to DSM-IV criteria.[6] All participants were on medication (class of anticholinesterasic), without other neurological conditions, psychiatric or cerebrovascular disease history, and were followed at the Behavioral Neurology Section of the Universidade Federal de São Paulo in 2010.

Study design

Subjects included in this study were classified and divided into groups according to educational level in formal years and previous professional activity from which they retired and in which they worked longest. Stratification with regard to previous occupation was performed such as into farm work, for any rural activity (cattle raising or vegetable cultivation). Similarly technical jobs at the same level were included in the same group.

For statistical analysis, two groups were compared: Group I – subjects classified as commerce workers, with middle or higher (University) education; Group II – rural and construction workers, and household domestics. After recording gender, age, formal education level and estimated time of disease duration, subjects were submitted to the Clinical Dementia Rating (CDR),[7] MMSE[8] and specific sub items of the neuropsychological battery[9] (direct and inverse digit span, total score for immediate recall for three trials of a 10-word list, delayed recall of the same list, naming of 15 drawings from the Boston naming test and verbal fluency for animals).

Statistical methods

Descriptive analysis of all variables was carried out. For quantitative variables this was done using lowest and highest scores, mean and standard deviation. For qualitative variables, absolute and relative frequencies were calculated. On comparison between groups, normality of data distribution was rejected and the Mann-Whitney nonparametric test[10] was therefore used. To test homogeneity between proportions, the Chi-square test[10] or Fisher exact
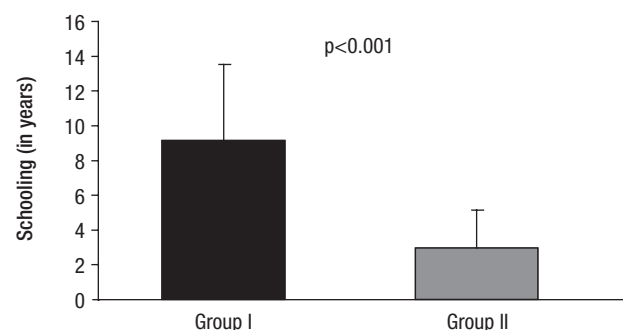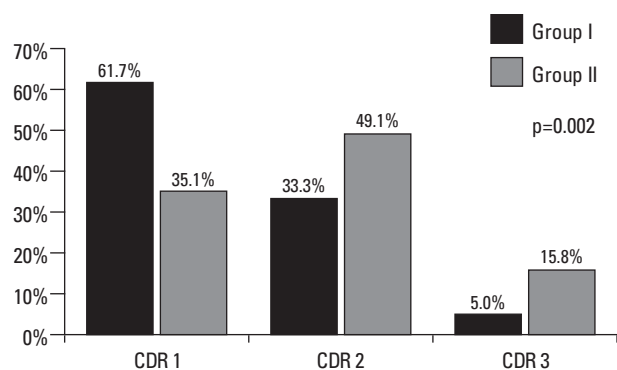

Figure 1. *Educational level.*

Figure 2. Disease stage (CDR) for Groups I and II .

Table 1. Distribution according to gender, CDR and previous occupation.

		Groups			
		I		II	
	Class	N	%	N	%
Gender	F	25	41.7	85	74.6
	M	35	58.3	29	25.4
CDR	1	37	61.7	40	35.1
	2	20	33.3	56	49.1
	3	3	5.0	18	15.8
Profession	Farming	0	0.0	14	12.3
	Building	0	0.0	21	18.4
	Home made	0	0.0	22	19.3
	House wife	0	0.0	57	50.0
	Graduation	13	21.7	0	0.0
	Technical	15	25.0	0	0.0
	Trading	32	53.3	0	0.0

test[10] (when expected frequencies were lower than 5) was used. Significance level was set at 5%.

Results

No difference in age (Group I – 74.35 years; Group II – 74.46 years) was found between the two groups. Differences in education between Groups I and II are shown in Figure 1 and reached significance for Group I (9.10±4.38) vs Group II (2.99±2.13). Comparing this variable with others revealed a correlation with all tests and with disease duration (Group I – 3.28±1.71; Group II – 2.52±1.35).

Table 1 shows a difference for gender in Group II,

which contained more females, while no difference was seen in Group II.

In terms of demographic and clinical data there was a higher incidence of moderate to moderately-severe disease in Group II (Figure 2). For Group I, most subjects were at an early stage of disease, while for Group II most subjects were at a moderate stage AD.

Table 2. Age, education, disease duration and neuropsychological performance.

	Group	N	Average	sd	Median	Minimo	Maximum
Age	I	60	74.35	7.64	75.00	57	96
	II	114	74.46	6.78	74.50	60	94
Schooling	I	60	9.10	4.38	8.00	3	16
	II	114	2.99	2.13	4.00	0	10
Disease duration (in years)	I	60	3.28	1.71	3.00	1	10
	II	114	2.52	1.35	2.00	1	8
MMSE	I	60	20.35	5.05	21.00	6	29
	II	114	15.96	5.10	15.50	2	27
Span F	I	60	5.47	1.28	6.00	3	8
	II	114	4.67	1.23	5.00	0	9
Span B	I	60	3.00	1.15	3.00	0	6
	II	114	1.94	1.12	2.00	0	4
Total list	I	60	10.23	3.58	10.00	2	20
	II	114	8.00	4.10	8.00	0	17
Evocation	I	60	1.05	1.44	0.00	0	6
	II	114	0.89	1.34	0.00	0	5
SVF	I	60	8.63	3.63	8.00	0	18
	II	114	7.35	3.07	7.00	1	15
Boston 15 items	I	60	11.35	3.07	12.00	2	15
	II	114	8.89	3.29	9.00	0	15

Table 3. Group I subgroups comparison.

	Profession	N	Average	sd	Median	Minimo	Maximum
Disease duration (in year)	Trading	32	3.00	1.68	3	1	8
	Graduation	13	3.54	1.27	3	2	6
	Technical	15	3.67	2.06	3	2	10
CDR	Trading	32	1.41	0.56	1	1	3
	Graduation	13	1.62	0.77	1	1	3
	Technical	15	1.33	0.49	1	1	2
MMSE	Trading	32	20.84	5.39	21	6	29
	Graduation	13	19.62	4.37	21	14	25
	Technical	15	19.93	5.04	21	9	28
Span B	Trading	32	3.03	1.23	3	0	6
	Graduation	13	2.69	1.18	3	0	4
	Technical	15	3.20	0.94	3	2	5
Total list	Trading	32	10.75	3.90	10	2	19
	Graduation	13	9.46	2.73	10	4	14
	Technical	15	9.80	3.53	8	7	20
SVF	Trading	32	8.66	3.24	8	3	15
	Graduation	13	7.69	4.42	7	0	13
	Technical	15	9.40	3.74	8	4	18

CDR: Clinical Dementia Rating; MMSE: Mini-Mental State exam; B: Digit Span Backward; Total List: Total of words recalled from CERAD word list (0-30); SVF: Semantic Fluency Verbal for animals.

Raw scores presented at Table 2 show that except for immediate recall there was a significant difference for all tests, from screening (MMSE) to attention, working memory, and language. Comparisons Group I subgroups (commerce workers, technical jobs and University graduated people), using Kruskal-Wallis test, showed no difference for neuropsychological performance, CDR and disease duration (Table 3).

Discussion

The relationship between dementia and more specifically, Alzheimer's disease, and education has been investigated since last decade, with largely concordant results. In line with previous studies,[11-14] the findings of this investigation showed that low education and less cognitively-demanding activities are a significant factor for high incidence and earlier manifestation of this disease. By contrast, the combined accumulation of educational experience and use of cognitively more complex abilities might strengthen the cognitive reserve and preserve both cognition and functionality.

There are suggestions that early intellectual demand, necessary for formal education and later for professional occupation, may be crucial in the formation of cognitive resources over the long term and these resources may persist even following the onset of dementia.[15] Evidence favoring this hypothesis is the objective demonstration, using neuropsychological tests, that those with lower formal education have more rapid decline following the first symptoms of dementia.[16] This study revealed that, according to educational level, individuals with more years of formal studies had a delayed onset of symptoms and that ,from diagnosis, cognitive decline was less marked in this group.

Despite increasing evidence favoring this hypothesis (for a review see Paradise et al.[17]), not all less educated individuals or those working in less demanding activities will have an earlier death, thus indicating that survival might be related to other factors other than cognitive reserve.

Our investigation identified three classes of patients with three different levels of education and activity, that had equivalent education and activity, with regard to first symptoms of dementia and neuropsychological performance. However, the authors note that more data are needed to establish which factors are actually protective against early appearance and manifestation of neurodegenerative disease, along with studies including specific statistical regression analysis of clinical and sociodemographic variables.

References

1. Instituto Brasileiro de Geografia e Estatística – IBGE. (www.ibge.gov.br).
2. Kirsch US, Jungeblut A, Jenkins L, Kolstad A. Adult Literacy in

America. The National Adult Literacy Survey. National Center for Education Statistics, US Department of Education. Washington DC: US Government Printing Office, 1993.

3. Kozol J. Illiterate America. Garden City, NY: Anchor Press/Doubleday, 1985.

4. Weiss BD, Red RL, Kligman EK. Literacy skills and comunication methods of low-income older persons. Patient Educ Counseling 1995;43:1523-1528.

5. Castell LS, MacLennan A. On defining Literacy. In. Literacy, Society and Schooling: A reader. Cambridge, Cambridge University Press; 1986.

6. American Psychiatric Association. Diagnostic and Statistical Manual of Mental Disorders. 4th edition. Washington: American Psychiatric Association.

7. Hughes CP, Berg L, Danziger WL. A new clinical scale for the staging dementia. Br J Psychiatr 1982;140:566-572.

8. Bertolucci PH, Brucki SM, Campacci SR, Juliano Y. O Mini-exame do estado mental em uma população geral: impacto da escolaridade. Arq Neuropsiquiatr 1994;52:1-7.

9. Morris J, Edland S, Clark C, Galasko D, Koss E, Mohs R, van Belle G, Fillenbaum G, Heiman A. The consortium to establish a registry for Alzheimer's disease (CERAD). Part IV. Neurology 1993;43:2457-2465.

10. Rosner, B. Fundamentals of Biostatistics, Second edition. Boston, PWS Publishers; 1986.

11. Stern Y, Gurland B, Tatemich TK, Tang MX, Wilder D, Mayeux R. Influence of education and occupation on the incidence of Alzheimer's disease. JAMA 1994;271:1004-1010.

12. Cobb JL, Wolf PA, Au R, White R, D'Agostino RB. The effect of education on the incidence of dementia and Alzheimer's disease in the Framingham Study. Neurology 1995;45:1707-1712.

13. Qiu C, Backman L, Winblad B, Aguero-Torres H, Fratiglione L. The influence of education on clinically diagnosed dementia incidence and mortality data from the Kungsholmen Project. Arch Neurol 2001;58:2034-2039.

14. Scarmeas N, Levy G, Tang M-x, Manly J, Stern Y. Influence of leisure activity on the incidence of Alzheimer's disease. Neurology 2001;57:2236-2242.

15. Gatz M, Prescott CA, Pedersen NL. Lifestyle risk and delaying factors. Alzheimer Dis Assoc Disord 2006;20:S84-S88.

16. Hall CB, Derby C, LeValley A, Katz MJ, Verghese J, Lipton RB. Education delays accelerated decline on a memory test in persons who develop dementia. Neurology 2007;69: 1657-1664.

17. Paradise M, Cooper C, Livingston G. Systematic review of the effect of education on survival in Alzheimer's disease. Int Psychogeriatrics 2009;21:25-32.